

# PATENT ABSTRACTS OF JAPAN

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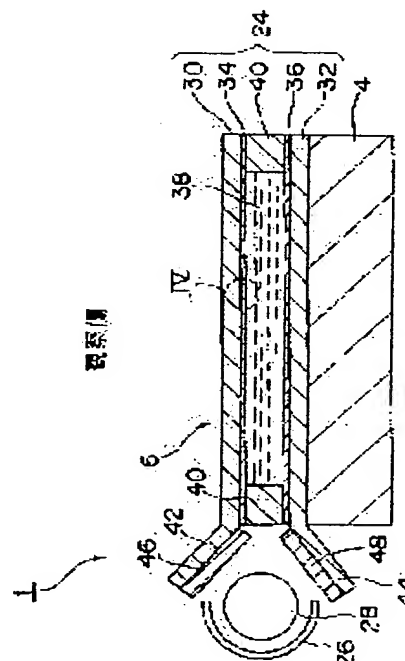
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(54) LIGHT UNIT, LIGHT GUIDING BOARD, LIGHT GUIDE AND DISPLAY UNIT USING THIS LIGHT GUIDE

(57)Abstract:

**PROBLEM TO BE SOLVED:** To provide a liquid crystal display unit which has members with both a touch panel function and light guiding function on the front of a liquid crystal panel.

**SOLUTION:** The liquid crystal panel 1 consists of a light guiding panel 24 laid on the observation side of the liquid crystal panel 4 and a light source 28 which is counter-positioned to the side of this light guiding panel. The light guiding panel 24 has upper and lower boards 30 and 32 which are laid out at a predetermined interval, and upper and lower transparent electric conduction films 34 and 36 inside these boards and a light penetrating liquid 38 installed between these electric conduction films. The liquid 38 is enclosed in the light guiding panel 24 by a light penetrating sheet member 40 laid out continuously along the circumferential edge of the upper and lower boards 30 and 32. When a force is applied to the upper board 30, it transforms and pushes away the liquid 38 so that a part of the upper electric conduction film on which the force is applied makes contact with a part of the lower electric conduction film. As a result, an electric circuit including this contact part is formed and the position where a force has been acted upon is detected.



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CLAIMS

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[Claim(s)]

- [Claim 1] It is the display which has a display device for displaying using the light by which incidence is carried out from the transparent material which carries out the light guide of the light, and said transparent material, and is characterized by said transparent material carrying out the light guide of the light through a translucency liquid.
- [Claim 2] Said transparent material is the display of claim 1 characterized by being arranged from said display device at an observation side.
- [Claim 3] Said transparent material is claim 1 or the display of 2 characterized by being the light guide plate which comes to pinch said translucency liquid between the substrates of the couple which opened predetermined spacing mutually and has been arranged.
- [Claim 4] The refractive index of said translucency liquid is the display of claim 3 which is almost the same as the refractive index of the substrate of said couple, or is characterized by being larger than it.
- [Claim 5] It is the display of claim 2 characterized by the substrate by the side of observation at least having flexibility among the substrates of said couple.
- [Claim 6] Said light guide plate is the display of claim 5 characterized by serving as the touch panel which has a location detection function.
- [Claim 7] Said translucency liquid is the display of claim 6 characterized by having insulation.
- [Claim 8] Claim 1 characterized by establishing the light source near at least one side face of said light guide plate, and this drawing the light of the light source in a light guide plate through this side face, or 2 displays.
- [Claim 9] It is the display of claim 8 characterized by processing the front face of one [ at least ] substrate so that the light from said light source may be reflected in a display device side among the substrates of said couple.
- [Claim 10] Said light source is the display of claim 8 characterized by being an organic electroluminescent element.
- [Claim 11] Said display device is a display according to claim 2 to 10 characterized by being a reflective mold liquid crystal display component.
- [Claim 12] The transparent material which performs a light guide through a translucency liquid.
- [Claim 13] The light guide plate which has the function of performing location detection by having with the translucency liquid pinched between the bottom substrate, the upside substrate which has flexibility, opened this bottom substrate and predetermined spacing, and has been arranged, and the bottom and an upside substrate substrate, turning some upside substrates to a bottom substrate in the light guide plate which takes in light from the outside and carries out outgoing radiation to a display device, and deforming.
- [Claim 14] The light guide plate of claim 13 which performs location detection by contacting some conductive layer parts of said upside substrate into the conductive layer part of the bottom substrate which counters this conductive layer part by having the bottom and the upside conductive layer which were prepared in the mutual opposed face of said bottom and an upside substrate, respectively, and

turning and deforming some upside substrates into a bottom substrate.

[Claim 15] The light unit equipped with the light source and the light guide material which has a translucency liquid for carrying out the light guide of the light from the light source.

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the light unit which illuminates a display device (for example, liquid crystal panel) to homogeneity, a transparent material, the light guide plate which makes a touch panel serve a double purpose, and the display equipped with the transparent material.

[0002]

[Background of the Invention] Conventionally, prepare a light guide plate in the front face (observation side) of the reflective mold liquid crystal panel which displays from an observation side using the light by which incidence is carried out, the side face of this light guide plate is made to carry out incidence of the light from the light source of a fluorescent lamp etc., and the front light mold liquid crystal display which displays by leading light to the liquid crystal layer of a liquid crystal panel from a light guide plate further is known.

[0003] The liquid crystal display with a touch panel which prepared protection members (translucency member), such as a touch panel, in the front face of a light guide plate further is proposed about this front light mold liquid crystal display. However, with this equipment, since the laminating of a light guide plate and the touch panel was carried out, the problem which permeability falls and can check a display by looking good neither by an echo in interfaces (interface between the substrates which constitute a touch panel, and which prepared the electric conduction film and this electric conduction film, for example etc.), nor the echo by the air space (thin layer of the air produced among these members when a touch panel is joined to a light guide plate) had arisen. Moreover, it will be contrary to want that he wants to make a liquid crystal display into a thin shape as much as possible to incorporate a touch panel further.

[0004] Then, this invention is preparing the member combining and [ touch panel ] and a light guide function in the front face of a liquid crystal panel, and solves the above-mentioned problem.

[0005] Moreover, this invention sets it as other objects to offer the new front light unit useful to solution, light guide plate, and transparent material of the above-mentioned problem.

[0006]

[Embodiment of the Invention] Hereafter, the gestalt of suitable operation of this invention is explained with reference to an accompanying drawing. Although the liquid crystal panel is adopted as a display device in the following explanation, as long as the display device used for this invention is a display device which is not limited to a liquid crystal panel and does not emit light itself, what kind of thing is sufficient as it.

[0007] (1st operation gestalt) The liquid crystal display which expresses the whole with a sign 1 in drawing 1 has a liquid crystal panel 4, the front light unit 6 for being arranged in the drawing upper part (observation side) of a liquid crystal panel 4, and irradiating light at a liquid crystal panel 4, and a display and control section (not shown) for controlling a liquid crystal panel 4, and sheathing of these is carried out by the sheathing member (not shown). The liquid crystal panel 4 has the optical absorption layer 8 and three color specification layers 10 (green display layer 10G, red display layer 10R, and blue display layer 10B).

display layer 10B) by which the laminating was carried out on the optical absorption layer 8.

[0008] As shown in drawing 2, each color specification layer 10 has the liquid crystal 18 with which the gap formed with the resin structure 16 and the resin structure 16 for carrying out adhesion support of the upside substrate 12 and the bottom substrate 14 which consist of a transparent material, and these upside substrate 12 and the bottom substrate 14 was filled up. In addition, although the graphic display is omitted, the spherical spacer is also contained between vertical substrates. Moreover, two or more shape upside electrodes 20 of zona pellucida open predetermined spacing in the underside of the upside substrate 12, and it is arranged at parallel. On the other hand, two or more shape bottom electrodes 22 of zona pellucida open predetermined spacing in the top face of the bottom substrate 14, and it is arranged at parallel. The array direction of these upside electrode 20 and the bottom electrode 22 lies at right angles, and the point (intersection) that these upside electrode 20 and the bottom electrode 22 counter forms the pixel of a liquid crystal display 1.

[0009] The cholesteric liquid crystal which has selective reflection wavelength is used for the visible region by the liquid crystal 18 of each color specification layer 10. With this operation gestalt, the liquid crystal which performs blue selective reflection to display layer 10R by the side of an observer is used, the liquid crystal which performs green selective reflection to the following display layer 10G is used, and the liquid crystal which performs red selective reflection is used for the last display layer 10B. In addition, you may make it make an upside substrate and a bottom substrate serve a double purpose with one substrate in two display layers which adjoin each other mutually. If it does in this way, since the number of sheets of a substrate can be reduced, display grace can be raised.

[0010] Each color specification layer 10 answers the transparent electrode 20 of the upper and lower sides which pinch the liquid crystal 18 of the display layer 10, and the electrical potential difference impressed among 22, and changes from a selective reflection condition to the selective reflection condition of reflecting the light of specific wavelength selectively from the transparence condition which penetrates the light, or reverse to a transparence condition. Therefore, if the specific color specification layer 10 is made into a selective reflection condition and the white lights, such as the natural light, are irradiated towards a liquid crystal panel 4 from the upper part of drawing 2, the color specification layer 10 of a selective reflection condition will reflect the light of specific wavelength, and this will be observed as each color specification. When the color specification layer 10 is in a transparence condition, incident light penetrates this color specification layer 10. For this reason, desired color specification can be performed by making into a selective reflection condition the color specification layer 10 equivalent to the color which it is going to display, and making into a transparence condition the color specification layer 10 which is in an observer side rather than this color specification layer 10 at least. Moreover, in all the color specification layers 10, a transparence condition, then incident light are absorbed by the optical absorption layer 8, and serve as a black display.

[0011] As cholesteric liquid crystal contained in each color specification layer 10, itself can use the liquid crystal ingredient containing the cholesteric liquid crystal in which a cholesteric phase is shown at a room temperature, the liquid crystal ingredient which added chiral material to the nematic liquid crystal. If a pulse voltage with these comparatively expensive cholesteric liquid crystal is impressed, a planar condition will be chosen, and if a comparatively low pulse voltage is impressed, a focal conic condition will be chosen. Moreover, impression of the middle electrical-potential-difference pulse chooses the condition that the planar condition and the focal conic condition were intermingled. If P and the average refractive index of liquid crystal are set to n for the spiral pitch of liquid crystal when cholesteric liquid crystal is in a planar condition, the light of wavelength  $\lambda = P/n$  will be selectively reflected by liquid crystal. Moreover, when the selective reflection wavelength of liquid crystal has cholesteric liquid crystal in an infrared region in the state of focal conic, the light is scattered about, when selective reflection wavelength is shorter than it, dispersion becomes weak and the light is penetrated. Halftone will be displayed if cholesteric liquid crystal is in the condition that the planar condition and the focal conic condition were intermingled. Therefore, a display can be changed by the specific color (planar condition), black (focal conic condition), and its halftone by setting selective reflection wavelength as the light and forming the optical absorption layer 8 in an opposite hand a liquid

crystal panel 4 observation-side.

[0012] A red display can be performed by making blue display layer 10B and green display layer 10G into the transparence condition from which the cholesteric-liquid-crystal ingredient changed into the focal conic condition by this, and making red display layer 10R into the selective reflection condition from which cholesteric liquid crystal changed into the planar condition. Moreover, yellow can be displayed by making blue display layer 10B into the transparence condition from which the cholesteric-liquid-crystal ingredient changed into the focal conic condition, and making green display layer 10G and red display layer 10R into the selective reflection condition from which cholesteric liquid crystal changed into the planar condition. Similarly, the display of red, green, blue, white, cyanogen, a Magenta, yellow, and black is possible by choosing a transparence condition and a selective reflection condition for the condition of each color specification layer 10 suitably. By furthermore choosing a middle selective reflection condition as a condition of each color specification layer 10, neutral colors are displayed and a full color display can be performed. As for each above-mentioned condition (a focal conic condition, a planar condition, intermediate state), after pulse-voltage impression can maintain the condition (that is, it has memory nature.).

[0013] If drawing 1 and 3 are referred to, since the front light unit 6 will carry out the light guide of the light and will irradiate a liquid crystal panel 4 at homogeneity, at least one side face (side face extended in the direction of a front flesh side of the drawing 3 space) of the light guide panel 24 joined to the liquid crystal panel 4 and the light guide panel 24 is countered, and it is arranged, and has the light source 28 (for example, sources of the white light, such as white LED and a cold cathode tube) which allotted the reflector 26 to the tooth back. Although the light source 28 is the line light source, you may make it make the above-mentioned whole light guide panel side face carry out incidence of the light with this operation gestalt using the point light source.

[0014] While the light guide panel 24 concerning this invention carries out the light guide of the light, a touch panel is made to serve a double purpose (that is, it has a location detection function.). The upside and the bottom substrates 30 and 32 which opened predetermined spacing mutually and have been concretely arranged as the light guide panel 24 is shown in drawing 3, The upside and bottom transparence electric conduction film 34 and 36 (for example, ITO film, IZO film) which were stuck inside these substrates 30 and 32, respectively, It has a spherical spacer (not shown) for holding the gap between these electric conduction film 34 and 36 to Mr. abbreviation 1, and the electric conduction film 34 and the liquid 38 pinched among 36. The liquid 38 is enclosed in the light guide panel 24 by the seal member 40 arranged continuously [ near the periphery section of the upside substrate 30 and the bottom substrate 32 ]. The ingredient of an upside and the bottom substrates 30 and 32 is transparent, if the upside substrate 30 (substrate of the side which counters a user (observer)) has flexibility at least, what kind of thing may be used, for example, transparence resin, such as polycarbonate resin, acrylic resin, polyester resin, polystyrene resin, and polyolefine system resin, will be mentioned. A transparent material is suitable for the ingredient of a spacer, for example, glass, a silica, polyolefine system resin, etc. are mentioned. It is transparent, and it is good, and the seal member 40 has flexibility, and in addition, it is desirable. For example, what is necessary is just to use resin, such as urethane resin, an epoxy resin, and acrylic resin.

[0015] Although what kind of thing is sufficient as the ingredient of a liquid 38 as long as it has translucency and a refractive index has insulation highly comparatively, the refractive index is comparable as the refractive index of an upside and the bottom substrates 30 and 32, or what is larger than it is suitable for it. About the insulation of a liquid 38, what is necessary is just  $10E+10$  ohm/cm extent or more than it in a volume resistivity. As an ingredient with which are satisfied of insulating conditions, although isoparaffin system hydrocarbon oil, silicone system oil, denaturation silicone oil, refraction liquid, etc. are mentioned, if the magnitude of a refractive index is taken into consideration, refraction liquid is the most suitable.

[0016] An upside and the bottom substrates 30 and 32 have the extensions 42 and 44 extended [ to / from the light guide panel 24 / near the light source 28 near the lower part near the upper part ] to the side which counters the light source 28 of the light guide panel 24, respectively. The light source 28 is

countered, and the reflective film 46 and 48 forms aluminum, Au, Ag, Cu, Cr, nickel, etc. in an extension 42 and 44 front faces by a spatter etc., and is formed in them. According to this configuration, by direct or the reflector 26, and the reflective film 46 and 48, 1 time or after carrying out a multiple-times echo, incidence of the light from the light source 28 is carried out to the transparent liquid 38 through the transparent seal member 40. The configuration of the reflective film 46 and 48 may be not only a flat surface but a curved surface that what is necessary is to just be chosen so that the light from the light source 28 may be reflected efficiently and it can lead to the light guide panel 24 (liquid 38). In addition, if a reflector 26 is extended and formed to the location of drawing where the reflective film 46 and 48 is arranged, extensions 42 and 44 and the reflective film 46 and 48 are omissible.

[0017] Processing formation of the projection of the shape for example, of a saw etc. with a detailed cross section is carried out, by this, the underside of the upside substrate 30 of the light guide panel 24 is efficient, and reflects the light from the light source 28, and it is made to have led it to the liquid crystal panel 4, as shown in drawing 4. You may make it change the include angle for a point of a saw, the pitch of a saw, etc. according to the distance from the light source 28.

[0018] the above-mentioned processing -- the underside of the upside substrate 30 -- or -- instead, although you may give the top face of the bottom substrate 32, it is more desirable to process only one field, in order not to reduce the permeability of light beyond the need. In addition, instead of the above-mentioned processing, sandblasting etc. is processed on this underside and it prints, and even if vitrified, it is good, so that light may be scattered about on the underside of the upside substrate 30. However, it is more desirable to perform the above-mentioned processing for an echo from the directivity of light or the field of utilization effectiveness.

[0019] As for the top face of the upside substrate 30, it is desirable to carry out rebound ace court processing for the purpose of protection. Moreover, as for the underside of the bottom substrate 32, it is desirable to carry out acid-resisting processing.

[0020] By the way, since the conventional light guide plate consisted of solid-states which do not have flexibility, it deformed by contact by change of ambient temperature, and the external body, and the problem that a display device could not be compared with homogeneity through a light guide plate by this had produced it. On the other hand, since a liquid 38 absorbs the internal stress of the substrate by change of ambient temperature, and the external force by contact of an external body, the light guide panel 24 concerning this invention cannot deform the upside substrate 30, therefore it can illuminate a liquid crystal panel 4 to homogeneity.

[0021] Next, the touch panel input operation of a liquid crystal display 1 is explained using drawing 5. If a user pushes the upside substrate 30 of the light guide panel 24 with the input pen 50, the upside substrate 30 will deform, as shown in drawing, and a liquid 38 will be pushed away. By this The upside electric conduction film part corresponding to the location pushed with the input pen 50 contacts a bottom electric conduction film part (the spacer which could come, simultaneously has been arranged between the upside substrate 30 and the bottom substrate 32 and which is not illustrated may be crushed in the direction of the force, or may not be crushed, or whichever is sufficient as it.). . Consequently, the electrical circuit (not shown) containing this flow part 51 is formed, and the location pushed with the input pen 50 is detected.

[0022] Although the upside electric conduction film 34 and the bottom electric conduction film 36 have adopted the analog type formed over the underside of the upside substrate 30, and the whole abbreviation surface of the top face of the bottom substrate 32, respectively, the location detection method of this operation gestalt You may be the digital type with which it is formed in band-like [ which an upside and the bottom electric conduction film opened predetermined spacing mutually, respectively and have arranged to parallel instead / two or more ], and a type and the array direction of these band-like electric conduction film cross at right angles mutually. Moreover, as a location detection method, with this operation gestalt, although the resistance film type was used, optical, an electrostatic-capacity type, an ultrasonic type, etc. may be used instead.

[0023] (2nd operation gestalt) The perspective view of the liquid crystal display which drawing 6 requires for the 2nd operation gestalt of this invention, drawing 7 (a), and (b) show the partial expanded



sectional view of this liquid crystal display. Liquid crystal display 1' of this operation gestalt makes it curve for the display [ at least / a part of ], and is formed. In order to realize such liquid crystal display 1', the film substrate made of resin which has flexibility is used as the upside and bottom substrate (it corresponds to the upside and the bottom substrates 12 and 14 of drawing 2 ) of liquid crystal panel 4'. Moreover, that in which not only upside substrate 30' but bottom substrate 32' has flexibility is chosen as an ingredient of the light guide panel 24' upside which pinches a liquid 38 and bottom substrate 30', and 32'. And these liquid crystal panel 4' and light guide panel 24' are joined, and using suitable supporter material (not shown), where liquid crystal panel 4' and light guide panel 24' are incurvated, it fixes. Thus, since light guide panel 24' and liquid crystal panel 4' have flexibility, a part for the display of liquid crystal display 1' can be easily made into a curved-surface configuration. in addition, the liquid crystal display display which curved by joining a light guide panel to this using what was formed in the predetermined bow configuration as a liquid crystal panel -- it can also provide (a liquid crystal panel functions as a base member (configuration attachment component) of a light guide panel in this case.) -- it is the point which can form a bow curved surface in arbitration, and it is suitable to use what has flexibility as a liquid crystal panel.

[0024] (3rd operation gestalt) Drawing 8 considers as the light source which carries out incidence of the light, and shows the amplification fragmentary sectional view of the liquid crystal display using the organic electroluminescence (EL) component which is a field emitter to a light guide panel. In liquid crystal display 1" of this operation gestalt, near the light guide panel 24 "upside substrate 30" edge (upper part of transparence seal member 40" which encloses a liquid 38), an organic EL device 52 is extended to a space perpendicular direction, and is arranged to it. The reflective film 54 is formed in the end face of seal member 40", and the light from an organic EL device 52 is reflected by the reflective film 54, and it is made to be led in a liquid 38. Since the light which carries out outgoing radiation from an organic EL device 52 is the diffused light, it is suitable to design the reflective film 54 in the shape of a curved surface, as shown in drawing so that light may carry out incidence efficiently into a liquid 38.

[0025] With this operation gestalt, by using the sheet metal-like organic EL device 52 as the light source, the tooth space which the light source section occupies compared with the light source 28 of the shape of tubing used with the 1st and 2nd operation gestalten can be made small, therefore a liquid crystal display can be miniaturized more. Moreover, it has the advantage that an organic EL device has little power consumed compared with the tubing-like light source 28 again.

[0026] In addition, an organic EL device may be arranged on the side face of not only the location of drawing but a light guide panel, or may be arranged in a seal member. Since incidence of the light is carried out to a direct liquid from an organic EL device in these cases, the reflective film is unnecessary.

[0027] As mentioned above, although the concrete operation gestalt of this invention was explained, this invention is variously [ not only in these but ] changeable. For example, a reflecting plate is formed in a tooth back instead of an optical absorption layer, and you may make it become a reflective mold as the whole liquid crystal panel as liquid crystal used for a liquid crystal panel using the own not high reflective liquid crystal but transparency mold liquid crystal of liquid crystal by selective reflection.

[0028] Moreover, with the above-mentioned operation gestalt, although the light guide panel which carries out the light guide of the light through a translucency liquid was making the touch panel serve a double purpose while being prepared in the front face of a liquid crystal panel, it can also apply the light unit which consists of the light source arranged on the side face of this light guide panel and a light guide panel to the liquid crystal display of the back light mold which arranges a lighting system at the tooth back (an observation side is an opposite hand) of a liquid crystal panel.

[0029] Drawing 9 shows an example of the back light mold liquid crystal display 58 which has arranged light guide panel 24'" concerning this invention at the tooth back of a liquid crystal panel 56. this light guide panel 24' -- the transparence electric conduction film is not prepared in 'the upside substrate of 'and bottom substrate 30', 32' (that is, it does not have a touch panel function.). Both the liquid crystal panel 56 used for this liquid crystal display 58 and light guide panel 24'" have flexibility, and are being fixed in the condition of having curved \*\* using suitable supporter material (not shown). Moreover, as a

liquid crystal panel 56, a transparency mold liquid crystal display component is used. TN mold and a STN mold liquid crystal display component using the pneumatic liquid crystal as a transparency mold liquid crystal display component can be used. Moreover, the transparency mold liquid crystal display component using a smectic liquid crystal or cholesteric liquid crystal is sufficient.

[0030]

[Effect of the Invention] Deformation by the medium of a liquid is possible, a light guide plate being equipped with a light guide function by performing a light guide with a liquid according to the display concerning this invention. Therefore, deformation by contact of an external body, the deformation based on change of ambient temperature, etc. are absorbed, a good light guide is performed, and a bright high-definition display is always possible. This point is remarkable especially when a transparent material is arranged from a display device at an observation side.

[0031] Moreover, when a transparent material is the light guide plate which has a touch panel function, while being able to make both the functions of a light guide and location detection use also [ light guide plate ] and making a display into a thin shape, the number of components of a display is reducible. moreover -- since the echo produced by carrying out the laminating of the light guide plate and touch panel which are the conventional configuration can be lessened -- high contrast -- high -- a brightness display can be offered. It arranges to a light guide plate observation-side, and if the substrate by the side of observation is made into flexibility, it will be easy to give a touch panel function. In addition, since the light guide plate itself has flexibility when both substrates are made into flexibility, a form can be changed according to the configuration of a display panel etc., and a curved-surface configuration can be acquired easily.

[0032] Furthermore, a bright display can be maintained, when using the liquid crystal display component of a reflective mold, or when using the laminating mold liquid crystal display component containing two or more liquid crystal layers pinched among two or more substrates.

[0033] Deformation by the medium of a liquid is possible, having a light guide function according to the transparent material and light unit concerning this invention, in order for a liquid to perform a light guide. Therefore, deformation by contact of an external body, the deformation based on change of ambient temperature, etc. can be absorbed, and an always good light guide can be performed. Moreover, it becomes the configuration of having been suitable for making a touch panel function having.

[0034] According to the light guide plate concerning this invention, since it has both the functions of a light guide and location detection, components mark can be lessened and it is advantageous to improvement in permeability, or cost reduction.

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TECHNICAL FIELD

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[Field of the Invention] This invention relates to the light unit which illuminates a display device (for example, liquid crystal panel) to homogeneity, a transparent material, the light guide plate which makes a touch panel serve a double purpose, and the display equipped with the transparent material.

[0002]

[Background of the Invention] Conventionally, prepare a light guide plate in the front face (observation side) of the reflective mold liquid crystal panel which displays from an observation side using the light by which incidence is carried out, the side face of this light guide plate is made to carry out incidence of the light from the light source of a fluorescent lamp etc., and the front light mold liquid crystal display which displays by leading light to the liquid crystal layer of a liquid crystal panel from a light guide plate further is known.

[0003] The liquid crystal display with a touch panel which prepared protection members (translucency member), such as a touch panel, in the front face of a light guide plate further is proposed about this front light mold liquid crystal display. However, with this equipment, since the laminating of a light guide plate and the touch panel was carried out, the problem which permeability falls and can check a display by looking good neither by an echo in interfaces (interface between the substrates which constitute a touch panel, and which prepared the electric conduction film and this electric conduction film, for example etc.), nor the echo by the air space (thin layer of the air produced among these members when a touch panel is joined to a light guide plate) had arisen. Moreover, it will be contrary to want that he wants to make a liquid crystal display into a thin shape as much as possible to incorporate a touch panel further.

[0004] Then, this invention is preparing the member combining and [ touch panel ] and a light guide function in the front face of a liquid crystal panel, and solves the above-mentioned problem.

[0005] Moreover, this invention sets it as other objects to offer the new front light unit useful to solution, light guide plate, and transparent material of the above-mentioned problem.

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[Embodiment of the Invention] Hereafter, the gestalt of suitable operation of this invention is explained with reference to an accompanying drawing. Although the liquid crystal panel is adopted as a display device in the following explanation, as long as the display device used for this invention is a display device which is not limited to a liquid crystal panel and does not emit light itself, what kind of thing is sufficient as it.

[0007] (1st operation gestalt) The liquid crystal display which expresses the whole with a sign 1 in drawing 1 has a liquid crystal panel 4, the front light unit 6 for being arranged in the drawing upper part (observation side) of a liquid crystal panel 4, and irradiating light at a liquid crystal panel 4, and a display and control section (not shown) for controlling a liquid crystal panel 4, and sheathing of these is carried out by the sheathing member (not shown). The liquid crystal panel 4 has the optical absorption layer 8 and three color specification layers 10 (green display layer 10G, red display layer 10R, G and blue display layer 10B) by which the laminating was carried out on the optical absorption layer 8.

[0008] As shown in drawing 2, each color specification layer 10 has the liquid crystal 18 with which the

gap formed with the resin structure 16 and the resin structure 16 for carrying out adhesion support of the upside substrate 12 and the bottom substrate 14 which consist of a transparent material, and these upside substrate 12 and the bottom substrate 14 was filled up. In addition, although the graphic display is omitted, the spherical spacer is also contained between vertical substrates. Moreover, two or more shape upside electrodes 20 of zona pellucida open predetermined spacing in the underside of the upside substrate 12, and it is arranged at parallel. On the other hand, two or more shape bottom electrodes 22 of zona pellucida open predetermined spacing in the top face of the bottom substrate 14, and it is arranged at parallel. The array direction of these upside electrode 20 and the bottom electrode 22 lies at right angles, and the point (intersection) that these upside electrode 20 and the bottom electrode 22 counter forms the pixel of a liquid crystal display 1.

[0009] The cholesteric liquid crystal which has selective reflection wavelength is used for the visible region by the liquid crystal 18 of each color specification layer 10. With this operation gestalt, the liquid crystal which performs blue selective reflection to display layer 10R by the side of an observer is used, the liquid crystal which performs green selective reflection to the following display layer 10G is used, and the liquid crystal which performs red selective reflection is used for the last display layer 10B. In addition, you may make it make an upside substrate and a bottom substrate serve a double purpose with one substrate in two display layers which adjoin each other mutually. If it does in this way, since the number of sheets of a substrate can be reduced, display grace can be raised.

[0010] Each color specification layer 10 answers the transparent electrode 20 of the upper and lower sides which pinch the liquid crystal 18 of the display layer 10, and the electrical potential difference impressed among 22, and changes from a selective reflection condition to the selective reflection condition of reflecting the light of specific wavelength selectively from the transparence condition which penetrates the light, or reverse to a transparence condition. Therefore, if the specific color specification layer 10 is made into a selective reflection condition and the white lights, such as the natural light, are irradiated towards a liquid crystal panel 4 from the upper part of drawing 2, the color specification layer 10 of a selective reflection condition will reflect the light of specific wavelength, and this will be observed as each color specification. When the color specification layer 10 is in a transparence condition, incident light penetrates this color specification layer 10. For this reason, desired color specification can be performed by making into a selective reflection condition the color specification layer 10 equivalent to the color which it is going to display, and making into a transparence condition the color specification layer 10 which is in an observer side rather than this color specification layer 10 at least. Moreover, in all the color specification layers 10, a transparence condition, then incident light are absorbed by the optical absorption layer 8, and serve as a black display.

[0011] As cholesteric liquid crystal contained in each color specification layer 10, itself can use the liquid crystal ingredient containing the cholesteric liquid crystal in which a cholesteric phase is shown at a room temperature, the liquid crystal ingredient which added chiral material to the nematic liquid crystal. If a pulse voltage with these comparatively expensive cholesteric liquid crystal is impressed, a planar condition will be chosen, and if a comparatively low pulse voltage is impressed, a focal conic condition will be chosen. Moreover, impression of the middle electrical-potential-difference pulse chooses the condition that the planar condition and the focal conic condition were intermingled. If  $P$  and the average refractive index of liquid crystal are set to  $n$  for the spiral pitch of liquid crystal when cholesteric liquid crystal is in a planar condition, the light of wavelength  $\lambda = P - n$  will be selectively reflected by liquid crystal. Moreover, when the selective reflection wavelength of liquid crystal has cholesteric liquid crystal in an infrared region in the state of focal conic, the light is scattered about, when selective reflection wavelength is shorter than it, dispersion becomes weak and the light is penetrated. Halftone will be displayed if cholesteric liquid crystal is in the condition that the planar condition and the focal conic condition were intermingled. Therefore, a display can be changed by the specific color (planar condition), black (focal conic condition), and its halftone by setting selective reflection wavelength as the light and forming the optical absorption layer 8 in an opposite hand a liquid crystal panel 4 observation-side.

[0012] A red display can be performed by making blue display layer 10B and green display layer 10G

into the transparence condition from which the cholesteric-liquid-crystal ingredient changed into the focal conic condition by this, and making red display layer 10R into the selective reflection condition from which cholesteric liquid crystal changed into the planar condition. Moreover, yellow can be displayed by making blue display layer 10B into the transparence condition from which the cholesteric-liquid-crystal ingredient changed into the focal conic condition, and making green display layer 10G and red display layer 10R into the selective reflection condition from which cholesteric liquid crystal changed into the planar condition. Similarly, the display of red, green, blue, white, cyanogen, a Magenta, yellow, and black is possible by choosing a transparence condition and a selective reflection condition for the condition of each color specification layer 10 suitably. By furthermore choosing a middle selective reflection condition as a condition of each color specification layer 10, neutral colors are displayed and a full color display can be performed. As for each above-mentioned condition (a focal conic condition, a planar condition, intermediate state), after pulse-voltage impression can maintain the condition (that is, it has memory nature.).

[0013] If drawing 1 and 3 are referred to, since the front light unit 6 will carry out the light guide of the light and will irradiate a liquid crystal panel 4 at homogeneity, at least one side face (side face extended in the direction of a front flesh side of the drawing 3 space) of the light guide panel 24 joined to the liquid crystal panel 4 and the light guide panel 24 is countered, and it is arranged, and has the light source 28 (for example, sources of the white light, such as white LED and a cold cathode tube) which allotted the reflector 26 to the tooth back. Although the light source 28 is the line light source, you may make it make the above-mentioned whole light guide panel side face carry out incidence of the light with this operation gestalt using the point light source.

[0014] While the light guide panel 24 concerning this invention carries out the light guide of the light, a touch panel is made to serve a double purpose (that is, it has a location detection function.). The upside and the bottom substrates 30 and 32 which opened predetermined spacing mutually and have been concretely arranged as the light guide panel 24 is shown in drawing 3, The upside and bottom transparence electric conduction film 34 and 36 (for example, ITO film, IZO film) which were stuck inside these substrates 30 and 32, respectively, It has a spherical spacer (not shown) for holding the gap between these electric conduction film 34 and 36 to Mr. abbreviation 1, and the electric conduction film 34 and the liquid 38 pinched among 36. The liquid 38 is enclosed in the light guide panel 24 by the seal member 40 arranged continuously [ near the periphery section of the upside substrate 30 and the bottom substrate 32 ]. The ingredient of an upside and the bottom substrates 30 and 32 is transparent, if the upside substrate 30 (substrate of the side which counters a user (observer)) has flexibility at least, what kind of thing may be used, for example, transparence resin, such as polycarbonate resin, acrylic resin, polyester resin, polystyrene resin, and polyolefine system resin, will be mentioned. A transparent material is suitable for the ingredient of a spacer, for example, glass, a silica, polyolefine system resin, etc. are mentioned. It is transparent, and it is good, and the seal member 40 has flexibility, and in addition, it is desirable. For example, what is necessary is just to use resin, such as urethane resin, an epoxy resin, and acrylic resin.

[0015] Although what kind of thing is sufficient as the ingredient of a liquid 38 as long as it has translucency and a refractive index has insulation highly comparatively, the refractive index is comparable as the refractive index of an upside and the bottom substrates 30 and 32, or what is larger than it is suitable for it. About the insulation of a liquid 38, what is necessary is just  $10E+10$  ohm/cm extent or more than it in a volume resistivity. As an ingredient with which are satisfied of insulating conditions, although isoparaffin system hydrocarbon oil, silicone system oil, denaturation silicone oil, refraction liquid, etc. are mentioned, if the magnitude of a refractive index is taken into consideration, refraction liquid is the most suitable.

[0016] An upside and the bottom substrates 30 and 32 have the extensions 42 and 44 extended [ to / from the light guide panel 24 / near the light source 28 near the lower part near the upper part ] to the side which counters the light source 28 of the light guide panel 24, respectively. The light source 28 is countered, and the reflective film 46 and 48 forms aluminum, Au, Ag, Cu, Cr, nickel, etc. in an extension 42 and 44 front faces by a spatter etc., and is formed in them. According to this configuration,

by direct or the reflector 26, and the reflective film 46 and 48, 1 time or after carrying out a multiple-times echo, incidence of the light from the light source 28 is carried out to the transparent liquid 38 through the transparent seal member 40. The configuration of the reflective film 46 and 48 may be not only a flat surface but a curved surface that what is necessary is to just be chosen so that the light from the light source 28 may be reflected efficiently and it can lead to the light guide panel 24 (liquid 38). In addition, if a reflector 26 is extended and formed to the location of drawing where the reflective film 46 and 48 is arranged, extensions 42 and 44 and the reflective film 46 and 48 are omissible.

[0017] Processing formation of the projection of the shape for example, of a saw etc. with a detailed cross section is carried out, by this, the underside of the upside substrate 30 of the light guide panel 24 is efficient, and reflects the light from the light source 28, and it is made to have led it to the liquid crystal panel 4, as shown in drawing 4. You may make it change the include angle for a point of a saw, the pitch of a saw, etc. according to the distance from the light source 28.

[0018] the above-mentioned processing -- the underside of the upside substrate 30 -- or -- instead, although you may give the top face of the bottom substrate 32, it is more desirable to process only one field, in order not to reduce the permeability of light beyond the need. In addition, instead of the above-mentioned processing, sandblasting etc. is processed on this underside and it prints, and even if vitrified, it is good, so that light may be scattered about on the underside of the upside substrate 30. However, it is more desirable to perform the above-mentioned processing for an echo from the directivity of light or the field of utilization effectiveness.

[0019] As for the top face of the upside substrate 30, it is desirable to carry out rebound ace court processing for the purpose of protection. Moreover, as for the underside of the bottom substrate 32, it is desirable to carry out acid-resisting processing.

[0020] By the way, since the conventional light guide plate consisted of solid-states which do not have flexibility, it deformed by contact by change of ambient temperature, and the external body, and the problem that a display device could not be compared with homogeneity through a light guide plate by this had produced it. On the other hand, since a liquid 38 absorbs the internal stress of the substrate by change of ambient temperature, and the external force by contact of an external body, the light guide panel 24 concerning this invention cannot deform the upside substrate 30, therefore it can illuminate a liquid crystal panel 4 to homogeneity.

[0021] Next, the touch panel input operation of a liquid crystal display 1 is explained using drawing 5. If a user pushes the upside substrate 30 of the light guide panel 24 with the input pen 50, the upside substrate 30 will deform, as shown in drawing, and a liquid 38 will be pushed away. By this The upside electric conduction film part corresponding to the location pushed with the input pen 50 contacts a bottom electric conduction film part (the spacer which could come, simultaneously has been arranged between the upside substrate 30 and the bottom substrate 32 and which is not illustrated may be crushed in the direction of the force, or may not be crushed, or whichever is sufficient as it.). Consequently, the electrical circuit (not shown) containing this flow part 51 is formed, and the location pushed with the input pen 50 is detected.

[0022] Although the upside electric conduction film 34 and the bottom electric conduction film 36 have adopted the analog type formed over the underside of the upside substrate 30, and the whole abbreviation surface of the top face of the bottom substrate 32, respectively, the location detection method of this operation gestalt You may be the digital type with which it is formed in band-like [ which an upside and the bottom electric conduction film opened predetermined spacing mutually, respectively and have arranged to parallel instead / two or more ], and a type and the array direction of these band-like electric conduction film cross at right angles mutually. Moreover, as a location detection method, with this operation gestalt, although the resistance film type was used, optical, an electrostatic-capacity type, an ultrasonic type, etc. may be used instead.

[0023] (2nd operation gestalt) The perspective view of the liquid crystal display which drawing 6 requires for the 2nd operation gestalt of this invention, drawing 7 (a), and (b) show the partial expanded sectional view of this liquid crystal display. Liquid crystal display 1' of this operation gestalt makes it curve for the display [ at least / a part of ], and is formed. In order to realize such liquid crystal display



1', the film substrate made of resin which has flexibility is used as the upside and bottom substrate (it corresponds to the upside and the bottom substrates 12 and 14 of drawing 2 ) of liquid crystal panel 4'. Moreover, that in which not only upside substrate 30' but bottom substrate 32' has flexibility is chosen as an ingredient of the light guide panel 24' upside which pinches a liquid 38 and bottom substrate 30', and 32'. And these liquid crystal panel 4' and light guide panel 24' are joined, and using suitable supporter material (not shown), where liquid crystal panel 4' and light guide panel 24' are incurvated, it fixes. Thus, since light guide panel 24' and liquid crystal panel 4' have flexibility, a part for the display of liquid crystal display 1' can be easily made into a curved-surface configuration. In addition, the liquid crystal display which curved by joining a light guide panel to this using what was formed in the predetermined bow configuration as a liquid crystal panel -- it can also provide (a liquid crystal panel functions as a base member (configuration attachment component) of a light guide panel in this case.) -- it is the point which can form a bow curved surface in arbitration, and it is suitable to use what has flexibility as a liquid crystal panel.

[0024] (3rd operation gestalt) Drawing 8 considers as the light source which carries out incidence of the light, and shows the amplification fragmentary sectional view of the liquid crystal display using the organic electroluminescence (EL) component which is a field emitter to a light guide panel. In liquid crystal display 1" of this operation gestalt, near the light guide panel 24 "upside substrate 30" edge (upper part of transparency seal member 40" which encloses a liquid 38), an organic EL device 52 is extended to a space perpendicular direction, and is arranged to it. The reflective film 54 is formed in the end face of seal member 40", and the light from an organic EL device 52 is reflected by the reflective film 54, and it is made to be led in a liquid 38. Since the light which carries out outgoing radiation from an organic EL device 52 is the diffused light, it is suitable to design the reflective film 54 in the shape of a curved surface, as shown in drawing so that light may carry out incidence efficiently into a liquid 38.

[0025] With this operation gestalt, by using the sheet metal-like organic EL device 52 as the light source, the tooth space which the light source section occupies compared with the light source 28 of the shape of tubing used with the 1st and 2nd operation gestalten can be made small, therefore a liquid crystal display can be miniaturized more. Moreover, it has the advantage that an organic EL device has little power consumed compared with the tubing-like light source 28 again.

[0026] In addition, an organic EL device may be arranged on the side face of not only the location of drawing but a light guide panel, or may be arranged in a seal member. Since incidence of the light is carried out to a direct liquid from an organic EL device in these cases, the reflective film is unnecessary.

[0027] As mentioned above, although the concrete operation gestalt of this invention was explained, this invention is variously [ not only in these but ] changeable. For example, a reflecting plate is formed in a tooth back instead of an optical absorption layer, and you may make it become a reflective mold as the whole liquid crystal panel as liquid crystal used for a liquid crystal panel using the own not high reflective liquid crystal but transparency mold liquid crystal of liquid crystal by selective reflection.

[0028] Moreover, with the above-mentioned operation gestalt, although the light guide panel which carries out the light guide of the light through a translucency liquid was making the touch panel serve a double purpose while being prepared in the front face of a liquid crystal panel, it can also apply the light unit which consists of the light source arranged on the side face of this light guide panel and a light guide panel to the liquid crystal display of the back light mold which arranges a lighting system at the tooth back (an observation side is an opposite hand) of a liquid crystal panel.

[0029] Drawing 9 shows an example of the back light mold liquid crystal display 58 which has arranged light guide panel 24'" concerning this invention at the tooth back of a liquid crystal panel 56. this light guide panel 24' -- the transparency electric conduction film is not prepared in 'the upside substrate of 'and bottom substrate 30', 32' (that is, it does not have a touch panel function.). Both the liquid crystal panel 56 used for this liquid crystal display 58 and light guide panel 24'" have flexibility, and are being fixed in the condition of having curved \*\* using suitable supporter material (not shown). Moreover, as a liquid crystal panel 56, a transparency mold liquid crystal display component is used. TN mold and a STN mold liquid crystal display component using the pneumatic liquid crystal as a transparency mold

liquid crystal display component can be used. Moreover, the transparency mold liquid crystal display component using a smectic liquid crystal or cholesteric liquid crystal is sufficient.

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[Translation done.]



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EFFECT OF THE INVENTION

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[Effect of the Invention] Deformation by the medium of a liquid is possible, a light guide plate being equipped with a light guide function by performing a light guide with a liquid according to the display concerning this invention. Therefore, deformation by contact of an external body, the deformation based on change of ambient temperature, etc. are absorbed, a good light guide is performed, and a bright high-definition display is always possible. This point is remarkable especially when a transparent material is arranged from a display device at an observation side.

[0031] Moreover, when a transparent material is the light guide plate which has a touch panel function, while being able to make both the functions of a light guide and location detection use also [ light guide plate ] and making a display into a thin shape, the number of components of a display is reducible. moreover -- since the echo produced by carrying out the laminating of the light guide plate and touch panel which are the conventional configuration can be lessened -- high contrast -- high -- a brightness display can be offered. It arranges to a light guide plate observation-side, and if the substrate by the side of observation is made into flexibility, it will be easy to give a touch panel function. In addition, since the light guide plate itself has flexibility when both substrates are made into flexibility, a form can be changed according to the configuration of a display panel etc., and a curved-surface configuration can be acquired easily.

[0032] Furthermore, a bright display can be maintained, when using the liquid crystal display component of a reflective mold, or when using the laminating mold liquid crystal display component containing two or more liquid crystal layers pinched among two or more substrates.

[0033] Deformation by the medium of a liquid is possible, having a light guide function according to the transparent material and light unit concerning this invention, in order for a liquid to perform a light guide. Therefore, deformation by contact of an external body, the deformation based on change of ambient temperature, etc. can be absorbed, and an always good light guide can be performed. Moreover, it becomes the configuration of having been suitable for making a touch panel function having.

[0034] According to the light guide plate concerning this invention, since it has both the functions of a light guide and location detection, components mark can be lessened and it is advantageous to improvement in permeability, or cost reduction.

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[Translation done.]

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DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] The perspective view of the liquid crystal display concerning the 1st operation gestalt of this invention.

[Drawing 2] The detailed sectional view of the liquid crystal panel of drawing 1 .

[Drawing 3] The sectional view of the liquid crystal display of drawing 1 .

[Drawing 4] The expanded sectional view of the underside of the upside substrate of a light guide plate.

[Drawing 5] The amplification fragmentary sectional view showing a condition when external force acts to the light guide panel of the liquid crystal display of drawing 1 .

[Drawing 6] The perspective view of the liquid crystal display concerning the 2nd operation gestalt of this invention

[Drawing 7] (a) The partial expanded sectional view of the liquid crystal display of drawing 6 . (b) The partial expanded sectional view showing a condition when external force acts to the light guide panel of the liquid crystal display of drawing 6 .

[Drawing 8] The amplification fragmentary sectional view of the liquid crystal display concerning the 3rd operation gestalt of this invention.

[Drawing 9] The perspective view of the back light mold liquid crystal display which has arranged the light unit concerning this invention at the tooth back of a liquid crystal panel.

[Description of Notations]

1: A liquid crystal display, 4:liquid crystal panel, 6:front light unit, 8:optical absorption layer, 10:color specification layer, 24:light guide panel, 26:reflector, 28:light source, the upside substrate of 30:light guide panel, the bottom substrate of 32:light guide panel, 34: upside electric conduction film, 36: bottom electric conduction film, 38:translucency liquid, 40:seal member, 50:input pen, a 52:organic electroluminescent element, 56:liquid crystal panel, 58 : liquid crystal display.

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[Translation done.]

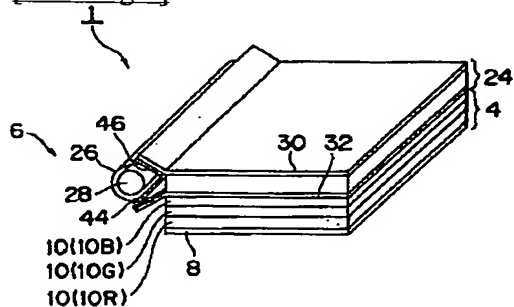
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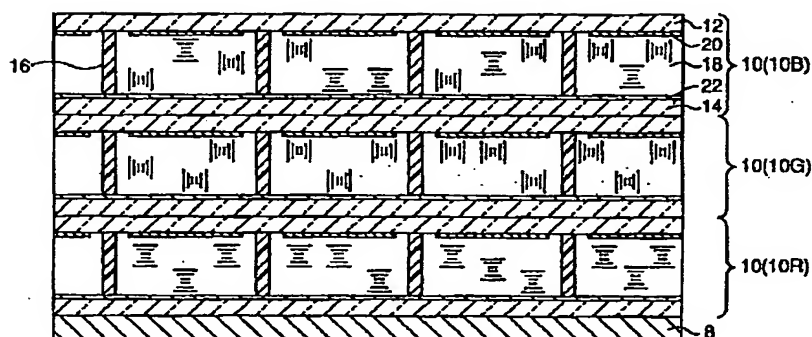
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## DRAWINGS

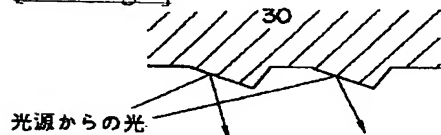
[Drawing 1]



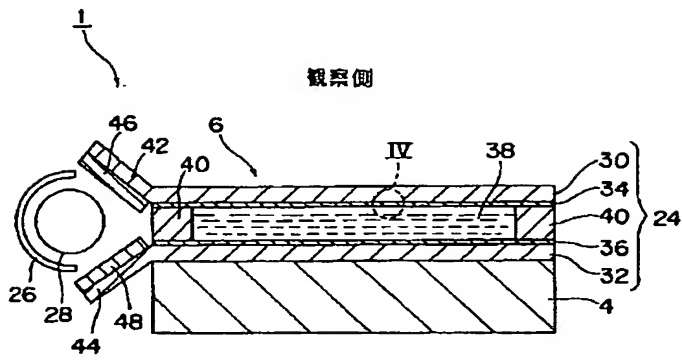
[Drawing 2]



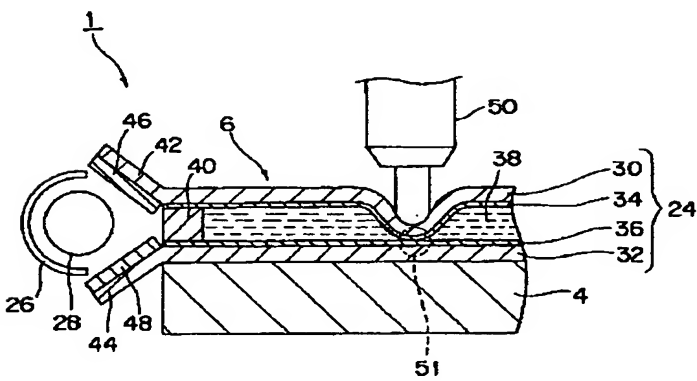
[Drawing 4]



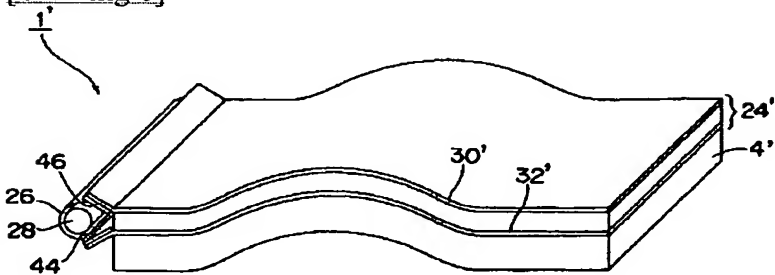
[Drawing 3]



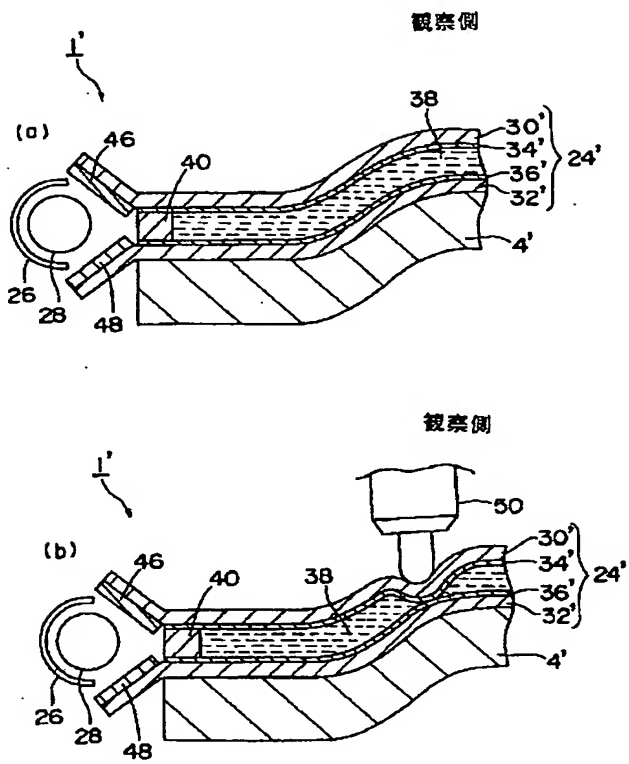
[Drawing 5]



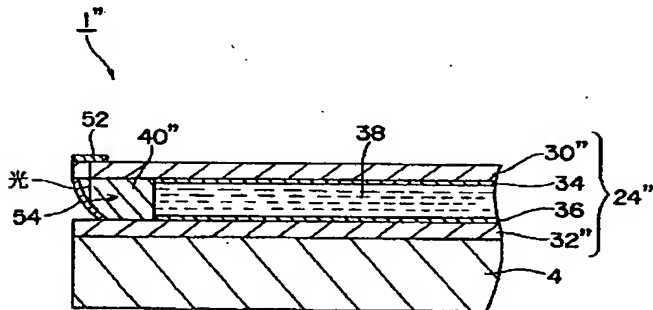
[Drawing 6]



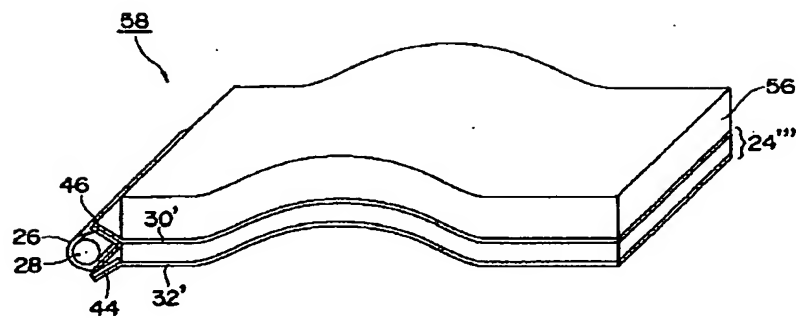
[Drawing 7]



[Drawing 8]



[Drawing 9]



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[Translation done.]

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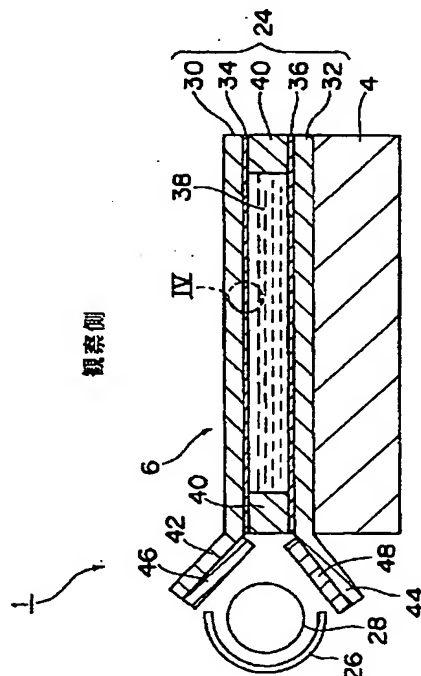
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(54) 【発明の名称】 ライトユニット、導光板、導光体及び該導光体を用いた表示装置

(57) 【要約】

【課題】 タッチパネル機能と導光機能を兼用する部材を液晶パネルの前面に設けた液晶表示装置を提供する。

【解決手段】 液晶表示装置1は、液晶パネル4の観察側に配置された導光パネル24と、この導光パネルの側面に対向して配置された光源28とを有する。導光パネル24は、互いに所定の間隔をあけて配置された上側及び下側基板30、32と、これら基板の内側にそれぞれ設けた上側及び下側透明導電膜34、36と、これら導電膜間に挟持された透光性液体38とを有する。液体38は、上側及び下側基板30、32の周縁部近傍に沿って連続的に配置された透光性シール部材40により導光パネル24内に封入されている。上側基板30に力を作ると、上側基板が変形して液体38を押し、これにより、力が作用した位置に対応する上側導電膜部分が下側導電膜部分に接触する。この結果、この接触部分を含む電気回路が形成され、力の作用した位置が検出される。



## 【特許請求の範囲】

【請求項 1】 光を導光する導光体と、  
前記導光体から入射される光を利用して表示を行うための表示素子を有し、  
前記導光体は、透光性液体を介して光を導光することを特徴とする表示装置。

【請求項 2】 前記導光体は、前記表示素子より観察側に配置されることを特徴とする請求項 1 の表示装置。

【請求項 3】 前記導光体は、互いに所定の間隔をあけて配置された一対の基板間に前記透光性液体を挟持してなる導光板であることを特徴とする請求項 1 又は 2 の表示装置。

【請求項 4】 前記透光性液体の屈折率は、前記一対の基板の屈折率とほぼ同じ又はそれより大きいことを特徴とする請求項 3 の表示装置。

【請求項 5】 前記一対の基板のうち少なくとも観察側の基板は、可撓性を有することを特徴とする請求項 2 の表示装置。

【請求項 6】 前記導光板は、位置検出機能を有するタッチパネルを兼ねることを特徴とする請求項 5 の表示装置。

【請求項 7】 前記透光性液体は、絶縁性を有することを特徴とする請求項 6 の表示装置。

【請求項 8】 前記導光板の少なくとも一つの側面の近傍に光源を設け、これにより該側面を介して導光板内に光源の光を導くことを特徴とする請求項 1 又は 2 の表示装置。

【請求項 9】 前記一対の基板のうち少なくとも一方の基板の表面は、前記光源からの光を表示素子側に反射するように加工されていることを特徴とする請求項 8 の表示装置。

【請求項 10】 前記光源は有機エレクトロルミネッセンス素子であることを特徴とする請求項 8 の表示装置。

【請求項 11】 前記表示素子は反射型液晶表示素子であることを特徴とする請求項 2～10 のいずれかに記載の表示装置。

【請求項 12】 透光性液体を介して導光を行う導光体。

【請求項 13】 光を外部から取り入れて表示素子に出射する導光板において、

下側基板と、

可撓性を有し、該下側基板と所定の間隔をあけて配置された上側基板と、

下側及び上側基板間に挟持された透光性液体と有し、

上側基板の一部を下側基板に向けて変形することにより位置検出を行う機能を有する導光板。

【請求項 14】 前記下側及び上側基板の互いの対向面にそれぞれ設けた下側及び上側導電層を有し、上側基板の一部を下側基板に向けて変形することによ

り、前記上側基板の一部の導電層部分をこの導電層部分に対向する下側基板の導電層部分に接触させることで位置検出を行う請求項 13 の導光板。

【請求項 15】 光源と、光源からの光を導光するための透光性液体を有する導光性部材とを備えたライトユニット。

## 【発明の詳細な説明】

## 【0001】

【発明の属する技術分野】 本発明は、表示素子（例えば液晶パネル）を均一に照明するライトユニット、導光体、タッチパネルを兼用する導光板、及び導光体を備えた表示装置に関する。

## 【0002】

【発明の背景】 従来、観察側から入射される光を利用して表示を行う反射型液晶パネルの前面（観察側）に導光板を設け、この導光板の側面に蛍光灯などの光源からの光を入射させ、さらに導光板から液晶パネルの液晶層に光を導くことで表示を行うフロントライト型液晶表示装置が知られている。

【0003】 このフロントライト型液晶表示装置に関して、導光板の前面にタッチパネル等の保護部材（透光性部材）をさらに設けたタッチパネル付き液晶表示装置が提案されている。しかしながら、この装置では、導光板とタッチパネルとが積層されているために、境界面（タッチパネルを構成する例えば導電膜と該導電膜を設けた基板との間の境界面など）での反射や空気層（導光板にタッチパネルを接合した場合にこれら部材間に生じる空気の薄層）での反射などにより、透過率が低下して良好に表示が視認できない問題が生じていた。また、タッチパネルをさらに組み込むことは、液晶表示装置をできる限り薄型にしたいとの要望に反することになる。

【0004】 そこで、本発明は、タッチパネル機能と導光機能を兼用する部材を液晶パネルの前面に設けることで、上記問題を解決するものである。

【0005】 また、本発明は、上記問題の解決に有用な新規なフロントライトユニット、導光板及び導光体を提供することを他の目的とする。

## 【0006】

【発明の実施の形態】 以下、添付図面を参照して本発明の好適な実施の形態を説明する。以下の説明では、表示素子として液晶パネルが採用されているが、本発明に用いられる表示素子は、液晶パネルに限定されず、自ら発光しない表示素子であればどのようなものでもよい。

【0007】（第 1 の実施形態）図 1 において全体を符号 1 で表わす液晶表示装置は、液晶パネル 4 と、液晶パネル 4 の図面上方（観察側）に配置され液晶パネル 4 に光を照射するためのフロントライトユニット 6 と、液晶パネル 4 を制御するための表示制御部（図示しない）とを有し、これらが外装部材（図示しない）により外装されている。液晶パネル 4 は、光吸収層 8 と、光吸収層 8



の上に積層された3つの色表示層10（赤色表示層10R、緑色表示層10G、青色表示層10B）とを有している。

【0008】図2に示すように、各色表示層10は、透明材料からなる上側基板12と下側基板14と、これら上側基板12と下側基板14とを接着支持するための樹脂構造物16と、樹脂構造物16によって形成された間隙に充填された液晶18を有する。なお、図示を省略しているが、上下基板の間には球状のスペーサも含まれている。また、上側基板12の下面には、複数の透明帯状上側電極20が所定の間隔をあけて平行に配置されている。他方、下側基板14の上面には、複数の透明帯状下側電極22が所定の間隔をあけて平行に配置されている。これら上側電極20と下側電極22の配列方向は直交しており、これら上側電極20と下側電極22とが対向する点（交点）が液晶表示装置1の画素を形成している。

【0009】各色表示層10の液晶18には、可視領域に選択反射波長を有するコレステリック液晶が使用されている。本実施形態では、観察者側の表示層10Rには青色の選択反射を行う液晶が使用され、次の表示層10Gには緑色の選択反射を行う液晶が使用され、最後の表示層10Bには赤色の選択反射を行う液晶が使用されている。なお、互いに隣り合う2つの表示層において、上側基板と下側基板とを1枚の基板で兼用するようにしてもよい。このようにすると、基板の枚数を減らすことができるので表示品位を高めることができる。

【0010】各色表示層10は、その表示層10の液晶18を挟持する上下の透明電極20、22間に印加される電圧に応答して、可視光を透過する透明状態から特定の波長の可視光を選択的に反射する選択反射状態へ、あるいは逆に、選択反射状態から透明状態へと切り替わる。したがって、特定の色表示層10を選択反射状態とし、図2の上方から液晶パネル4に向けて自然光等の白色光を照射すると、選択反射状態の色表示層10が特定波長の可視光を反射し、これが各色の表示として観察される。色表示層10が透明状態にあるときは、入射光が該色表示層10を透過する。このため、表示しようとする色に相当する色表示層10を選択反射状態とし、少なくともこの色表示層10よりも観察者側にある色表示層10を透明状態とすることにより、所望の色の表示を行うことができる。また、全ての色表示層10を透明状態とすれば、入射光が光吸収層8に吸収されて黒色表示となる。

【0011】各色表示層10に含まれるコレステリック液晶としては、それ自体が室温でコレステリック相を示すコレステリック液晶を含む液晶材料や、ネマチック液晶にカイラル材を添加した液晶材料などを用いることができる。これらのコレステリック液晶は、比較的高いパルス電圧が印加されるとプレーナ状態が選択され、比較

的低いパルス電圧が印加されるとフォーカルコニック状態が選択される。また、その中間の電圧パルスを印加すると、プレーナ状態とフォーカルコニック状態が混在した状態が選択される。コレステリック液晶がプレーナ状態の場合、液晶の螺旋ピッチをP、液晶の平均屈折率をnとすると、波長 $\lambda = P \cdot n$ の光が液晶によって選択的に反射される。また、コレステリック液晶がフォーカルコニック状態では、液晶の選択反射波長が赤外領域にある場合には可視光を散乱し、選択反射波長がそれよりも短い場合には散乱が弱くなり可視光が透過される。コレステリック液晶がプレーナ状態とフォーカルコニック状態が混在した状態にあると、中間調が表示される。したがって、選択反射波長を可視光に設定し、液晶パネル4の観察側と反対側に光吸収層8を設けることにより、特定色（プレーナ状態）と黒色（フォーカルコニック状態）、およびその中間調とで表示を切替えることができる。

【0012】これにより、例えば青色表示層10Bおよび緑色表示層10Gをコレステリック液晶材料がフォーカルコニック状態となった透明状態とし、赤色表示層10Rをコレステリック液晶がプレーナ状態となった選択反射状態とすることにより、赤色表示を行うことができる。また、青色表示層10Bをコレステリック液晶材料がフォーカルコニック状態となった透明状態とし、緑色表示層10G及び赤色表示層10Rをコレステリック液晶がプレーナ状態となった選択反射状態とすることにより、イエローの表示を行うことができる。同様に、各色表示層10の状態を透明状態と選択反射状態を適宜選択することにより赤、緑、青、白、シアン、マゼンタ、イエロー、黒の表示が可能である。さらに各色表示層10の状態として中間の選択反射状態を選択することにより中間色が表示され、フルカラー表示を行うことができる。上記各状態（フォーカルコニック状態、プレーナ状態、中間状態）は、パルス電圧印加後もその状態を保つことができる（すなわちメモリ性を有する。）

【0013】図1、3を参照すると、フロントライトユニット6は、光を導光し液晶パネル4に均一に照射するために、液晶パネル4と接合した導光パネル24と、導光パネル24の少なくとも一つの側面（図3紙面の表裏方向に伸びた側面）に対向して配置され、背面にリフレクタ26を配した光源28（例えば、白色LED、冷陰極管などの白色光源）とを有する。本実施形態では、光源28は線光源であるが、点光源を用いて光を上記導光パネル側面全体に入射させるようにしてもよい。

【0014】本発明に係る導光パネル24は、光を導光するとともに、タッチパネルを兼用する（すなわち位置検出機能を有する。）。具体的に、導光パネル24は、図3に示すように、互いに所定の間隔をあけて配置された上側及び下側基板30、32と、これら基板30、32の内側にそれぞれ貼り付けられた上側及び下側透明導

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電膜（例えばITO膜、IZO膜）34、36と、これら導電膜34、36間のギャップを略一様に保持するための球状のスペーサ（図示しない）と、導電膜34、36間に挟持された液体38とを有する。液体38は、上側基板30及び下側基板32の周縁部近傍に沿って連続的に配置されたシール部材40により導光パネル24内に封入されている。上側及び下側基板30、32の材料は、透明であって少なくとも上側基板30（ユーザ（観察者））に対向する側の基板）が可撓性を有すればどのようなものでもよく、例えば、ポリカーボネート樹脂、アクリル樹脂、ポリエステル樹脂、ポリスチレン樹脂、ポリオレフィン系樹脂などの透明樹脂が挙げられる。スペーサの材料は、透明材料が好適で、例えば、ガラス、シリカ、ポリオレフィン系樹脂などが挙げられる。シール部材40も、透明であればよく、可撓性を有すればなお好ましい。例えば、ウレタン樹脂、エポキシ樹脂、アクリル樹脂などの樹脂を用いればよい。

【0015】液体38の材料は、透光性を有し比較的屈折率が高く且つ絶縁性を有するものであればどのようなものでもよいが、その屈折率は、上側及び下側基板30、32の屈折率と同程度か、それより大きいのが好適である。液体38の絶縁性に関しては、体積抵抗率で $10E+10\Omega/cm$ 程度かそれ以上であればよい。絶縁性の条件を満足する材料として、イソパラフィン系炭化水素オイル、シリコン系オイル、変性シリコンオイル、屈折液などが挙げられるが、屈折率の大きさを考慮すると屈折液が最も好適である。

【0016】上側及び下側基板30、32は、導光パネル24の光源28に対向する側に、導光パネル24から光源28の上側部分近傍及び下側部分近傍まで伸びた延長部42、44をそれぞれ有する。延長部42、44表面には、光源28に対向して反射膜46、48が、例えばAl、Au、Ag、Cu、Cr、Niなどをスパッタなどで成膜して形成されている。この構成によれば、光源28からの光は、直接、あるいはリフレクタ26及び反射膜46、48で一回又は複数回反射した後で、透明なシール部材40を介して透明な液体38に入射する。反射膜46、48の形状は、光源28からの光を効率よく反射して導光パネル24（の液体38）に導くことができるように選択されればよく、平面に限らず曲面であってもよい。なお、リフレクタ26を、反射膜46、48の配置される図の位置まで延長して形成すれば、延長部42、44及び反射膜46、48は省略できる。

【0017】導光パネル24の上側基板30の下面は、図4に示すように、断面が例えば鋸状などの微細な突起が加工形成され、これにより、光源28からの光を高効率で反射し液晶パネル4に導くようにしてある。鋸の先端部分の角度や鋸のピッチ等を、光源28からの距離に応じて変化させるようにしてもよい。

【0018】上記加工は、上側基板30の下面とともに

あるいはその代わりに、下側基板32の上面に施してもよいが、光の透過率を必要以上に低下させないために、一方の面のみ加工する方が好ましい。なお、上記加工の代わりに、上側基板30の下面で光を散乱するように、該下面にサンドブラストなどの処理を施して摺りガラス状にしてもよい。しかしながら、光の指向性や利用効率の面からは、反射用の上記加工を施す方が好ましい。

【0019】上側基板30の上面は、保護目的でハードコート処理するのが好ましい。また、下側基板32の下面は反射防止処理するのが好ましい。

【0020】ところで、従来の導光板は、可撓性を有さない固体で構成されていたために、周囲温度の変化や、外部の物体による接触により変形し、これにより導光板を介して表示素子を均一に照らすことができないという問題が生じていた。これに対し、本発明に係る導光パネル24は、周囲温度の変化による基板の内部応力や、外部の物体の接触による外力を液体38が吸収するので上側基板30が変形せず、したがって、液晶パネル4を均一に照明することができる。

【0021】次に、図5を用いて液晶表示装置1のタッチパネル入力動作を説明する。ユーザが導光パネル24の上側基板30を入力ペン50で押すと、上側基板30が図のように変形して液体38を押しつけ、これにより、入力ペン50で押した位置に対応する上側導電膜部分が下側導電膜部分に接触する（これと同時に、上側基板30と下側基板32との間に配置された図示しないスペーサは力の方向につぶれても、つぶれなくてもどちらでもよい。）。この結果、この導通部分51を含む電気回路（図示しない）が形成され、入力ペン50で押した位置が検出される。

【0022】本実施形態の位置検出方式は、上側導電膜34及び下側導電膜36がそれぞれ、上側基板30の下面及び下側基板32の上面の略全面にわたって形成されたアナログ式を採用しているが、代わりに、上側及び下側導電膜がそれぞれ、互いに所定の間隔をあけて平行に配置した複数の帯状に形成され、これら帯状導電膜の配列方向が互いに直交するデジタル式であってもよい。また、位置検出方式として、本実施形態では、抵抗膜式を用いたが、代わりに、光学式、静電容量式、超音波式などを用いてもよい。

【0023】（第2の実施形態）図6は、本発明の第2の実施形態に係る液晶表示装置の斜視図、図7（a）、

（b）は該液晶表示装置の部分拡大断面図を示す。本実施形態の液晶表示装置1'は、その表示部分の少なくとも一部を湾曲させて形成されている。このような液晶表示装置1'を実現するために、液晶パネル4'の上側及び下側基板（図2の上側及び下側基板12、14に対応）として、例えば可撓性を有する樹脂製のフィルム基板を用いる。また、液体38を挟持する導光パネル24'の上側及び下側基板30'、32'の材料として、

上側基板 30' だけでなく下側基板 32' も可撓性を有するものを選択する。そして、これら液晶パネル 4' 及び導光パネル 24' を接合し、適当な支持部材 (図示しない) を用いて、液晶パネル 4' 及び導光パネル 24' を湾曲させた状態で固定する。このように導光パネル 24'、液晶パネル 4' とともに可撓性を有するので、液晶表示装置 1' の表示部分を容易に曲面形状にすることができる。なお、液晶パネルとして所定の湾曲形状に形成されたものを用い、これに導光パネルを接合することで湾曲した液晶表示装置表示部を提供することもできる

(この場合、液晶パネルが導光パネルのベース部材 (形状保持部材) として機能する。) が、湾曲曲面を任意に形成できる点で、液晶パネルとして可撓性を有するものを用いるのが好適である。

【0024】(第3の実施形態) 図8は、導光パネルに光を入射する光源として面発光体である有機エレクトロルミネッセンス (EL) 素子を用いた液晶表示装置の拡大断面図を示す。本実施形態の液晶表示装置 1' において、有機 EL 素子 52 は、導光パネル 24' の上側基板 30' 端部近傍 (液体 38 を封入する透明シール部材 40' の上方) に紙面垂直方向に伸びて配置されている。シール部材 40' の端面には反射膜 54 が形成されており、有機 EL 素子 52 からの光が反射膜 54 で反射されて液体 38 内に導かれるようにしてある。有機 EL 素子 52 から出射する光は拡散光であるので、液体 38 内に効率よく光が入射するように、反射膜 54 を図に示すように曲面状に設計するのが好適である。

【0025】本実施形態では、薄板状の有機 EL 素子 52 を光源として用いることにより、第1及び第2の実施形態で用いた管状の光源 28 に比べて光源部の占めるスペースを小さくでき、したがって液晶表示装置をより小型化することができる。また、有機 EL 素子はまた、管状の光源 28 に比べて消費される電力が少ないという利点を有する。

【0026】なお、有機 EL 素子は、図の位置に限らず、導光パネルの側面に配置してもよいし、あるいはシール部材内に配置してもよい。これらの場合、光は、有機 EL 素子から直接液体に入射するので、反射膜は不要である。

【0027】以上、本発明の具体的実施形態を説明したが、本発明はこれに限らず種々改変可能である。例えば、液晶パネルに用いられる液晶として、液晶自身の選択反射による反射型液晶ではなく、透過型液晶を用い、光吸収層の代わりに反射板を背面に設け液晶パネル全体として反射型となるようにしてもよい。

【0028】また、上記実施形態では、透光性液体を介して光を導光する導光パネルは、液晶パネルの前面に設けられるとともに、タッチパネルを兼用していたが、この導光パネル及び導光パネルの側面に配置した光源からなるライトユニットを、液晶パネルの背面 (観察側とは

反対側) に照明装置を配置するバックライト型の液晶表示装置に適用することもできる。

【0029】図9は、本発明に係る導光パネル 24' の液晶パネル 56 の背面に配置したバックライト型液晶表示装置 58 の一例を示す。この導光パネル 24' の上側基板及び下側基板 30'、32' には透明導電膜が設けられてない (すなわち、タッチパネル機能を有さない)。この液晶表示装置 58 に用いられる液晶パネル 56 及び導光パネル 24' は、ともに可撓性を有し、適当な支持部材 (図示しない) を用いて湾曲した状態で固定されている。また、液晶パネル 56 としては透過型液晶表示素子が用いられる。透過型液晶表示素子としては、ネマティック液晶を用いた TN 型や STN 型液晶表示素子を用いることができる。また、スメクティック液晶やコレステリック液晶を用いた透過型液晶表示素子でもよい。

【0030】

【発明の効果】本発明に係る表示装置によれば、導光板が液体により導光を行うことにより、導光機能を備えつつ、液体の媒体による変形が可能である。したがって、外部の物体の接触による変形や周囲温度の変化に基づく変形などを吸収して良好な導光が行われ、常に明るく高品位な表示が可能である。この点は、導光板が表示素子より観察側に配置される場合特に顕著である。

【0031】また、導光板がタッチパネル機能を有する導光板である場合は、導光板に導光及び位置検出の両機能を兼用させることができ、表示装置を薄型にできるとともに、表示装置の部品数を削減することができる。また、従来の構成である導光板とタッチパネルを積層することにより生じた反射を少なくすることができるので、高コントラストで高輝度な表示を提供することができる。導光板を観察側に配置し、観察側の基板を可撓性とするタッチパネル機能を持たせ易い。なお、両方の基板を可撓性とした場合は、導光板自体が可撓性を有するため、表示パネルの形状などに合わせて形を変更することができ、容易に曲面形状を得ることができる。

【0032】さらに、反射型の液晶表示素子を用いる場合や、複数の基板間に挟持された複数の液晶層を含む積層型液晶表示素子を用いる場合においても、明るい表示を保つことができる。

【0033】本発明に係る導光体及びライトユニットによれば、液体によって導光を行うため、導光機能を備えつつ、液体の媒体による変形が可能である。したがって、外部の物体の接触による変形や周囲温度の変化に基づく変形などを吸収して常に良好な導光を行うことができる。また、タッチパネル機能を兼ね備えさせるのに適した構成となる。

【0034】本発明に係る導光板によれば、導光及び位置検出の両機能を兼ね備えているので、部品点数を少なくすることができ、透過率の向上やコスト削減に有利で

ある。

【図面の簡単な説明】

【図1】 本発明の第1の実施形態に係る液晶表示装置の斜視図。

【図2】 図1の液晶パネルの詳細な断面図。

【図3】 図1の液晶表示装置の断面図。

【図4】 導光板の上側基板の下面の拡大断面図。

【図5】 図1の液晶表示装置の導光パネルに対し外力が作用したときの状態を示す拡大断面図。

【図6】 本発明の第2の実施形態に係る液晶表示装置の斜視図

【図7】 (a) 図6の液晶表示装置の部分拡大断面図。(b) 図6の液晶表示装置の導光パネルに対し外力が作用したときの状態を示す部分拡大断面図。

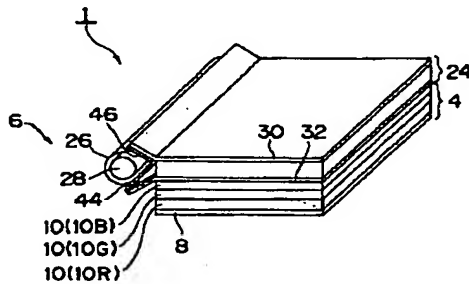
【図8】 本発明の第3の実施形態に係る液晶表示装置の拡大断面図。

【図9】 本発明に係るライトユニットを液晶パネルの背面に配置したバックライト型液晶表示装置の斜視図。

【符号の説明】

1：液晶表示装置、4：液晶パネル、6：フロントライトユニット、8：光吸収層、10：色表示層、24：導光パネル、26：リフレクタ、28：光源、30：導光パネルの上側基板、32：導光パネルの下側基板、34：上側導電膜、36：下側導電膜、38：透光性液体、40：シール部材、50：入力ペン、52：有機エレクトロルミネッセンス素子、56：液晶パネル、58：液晶表示装置。

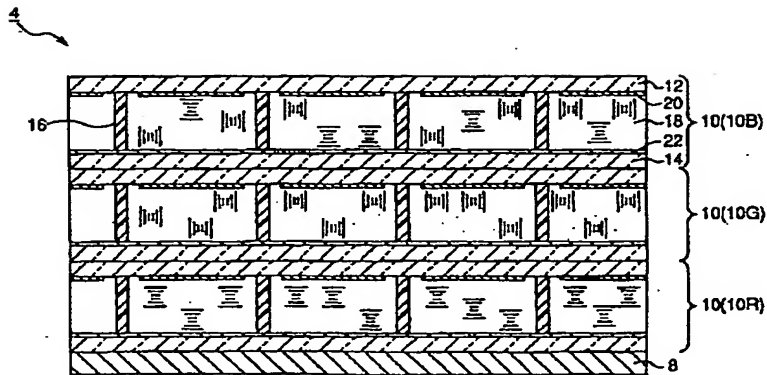
【図1】



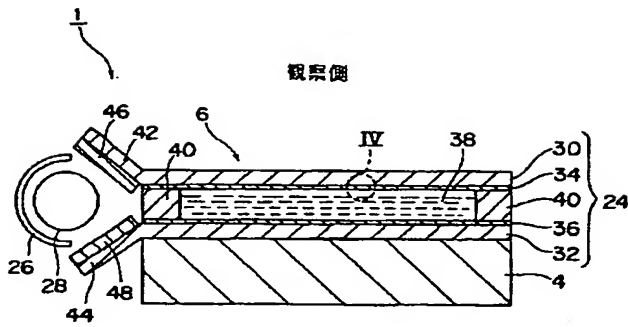
【図4】



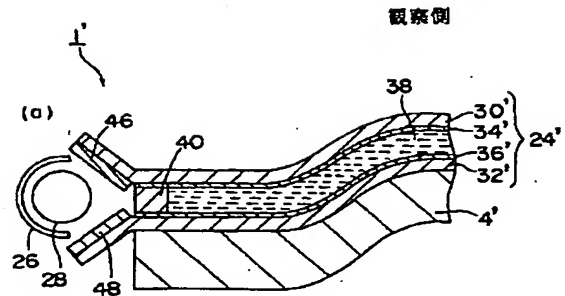
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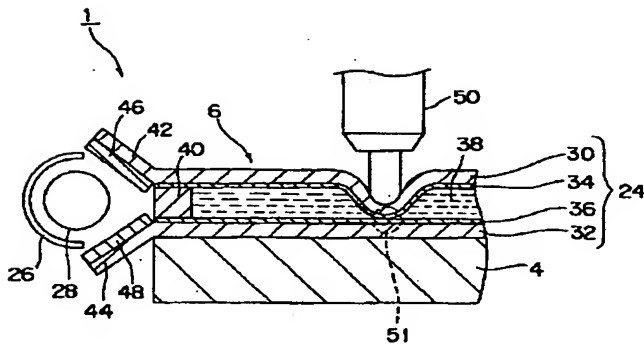
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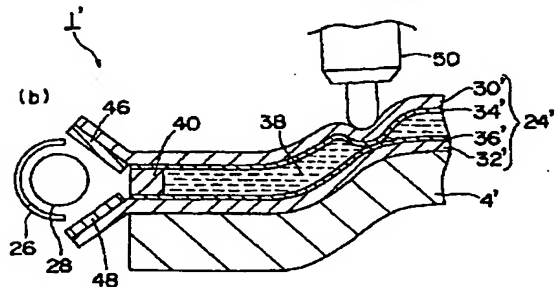
【図7】



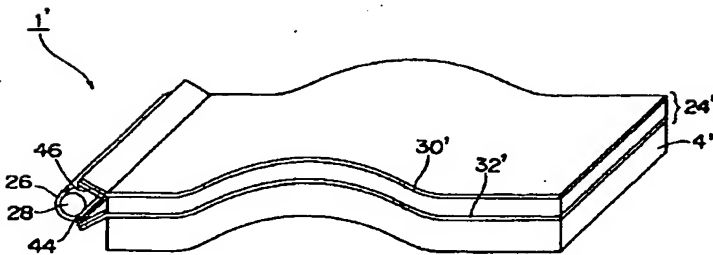
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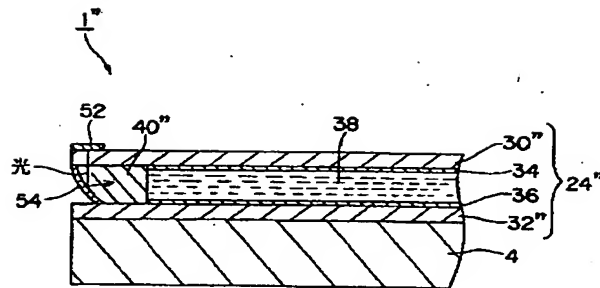
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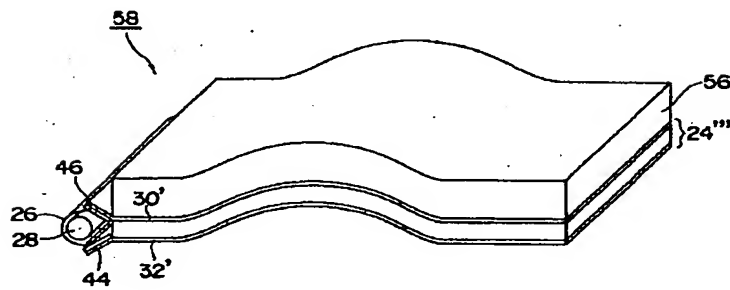
【図6】



【図8】



【図9】



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